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ENTERED AT STATIONERS' HALL.

ESSAY

ON THE

DISC AND DIFFE

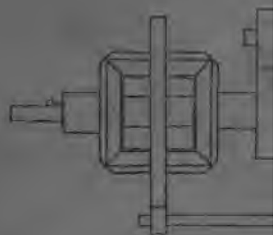
MOTION

AS APPLIED TO THE

MESSRS FAIRBAIRN, KENNEDY

ROVING MACH

Illustrated with Diagra



By JOSEPH HO

DUNDEE.

SECOND EDITION. REV

DUNDEE: JAMES P. MAT
LONDON: SIMPKIN, MARSH
EDINBURGH: JOHN MENZ

1883.

SAY

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with Diagrams.

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N, MARSHALL & CO.

JOHN MENZIES & CO.

1853.

ESSAY

ON THE

DISC AND DIFFERENTIAL MOTIONS,

AS APPLIED TO THE

MESSRS FAIRBAIRN, KENNEDY, AND NAYLOR'S ROVING MACHINES.

WITH RULES AND CALCULATIONS
FOR THE BOBBIN, AS A FOLLOWER AND LEADER, AND ITS
ADJUSTMENT TO ANY SIZE OF ROVE.

THE SCROLL, AND HOW TO MAKE IT, ETC.

Illustrated with Diagrams.

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NOTE.

THE following Essay was first delivered before the Association of Mill and Factory Managers, in Lamb's Hotel, Dundee, and met with their highest appreciation.

It was published by request, in the hope that by its perusal the Fairbairn Roving Machine might become as easily understood as any other less complicated machine employed in the Spinning trade. This edition having been sold out, and more copies having been urgently sought after by practical men, a new issue was rendered necessary.

The work has therefore been carefully revised, and, in order to make it more interesting and more easily understood by the young mechanic, two additional diagrams have been given, and some of the leading parts have been explained in a simple manner.

Any apprentice, with a knowledge of reading decimal values on the common foot-rule, may now become able, with a little patience, to make himself thoroughly master of this complicated machine.

CONTENTS.

PART FIRST.

PART SECOND.

ESSAY

ON THE

DISC AND DIFFERENTIAL MOTIONS.

PART FIRST.

1. The origin of increase or decrease of speed by a wheel revolving in its orbit while geared into another.

The differential motion, as it is now adapted to the roving, is in principle only a modification of what is known as James Watt's invention as a substitute for the crank, when the crank, as applied to the steam-engine, was patented. He discovered that by binding two wheels together, one fixed on the connecting rod and the other on the crank shaft, that an up and down of the connecting rod gave two revolutions of the shaft. Here was a discovery of the

speed being doubled by the first prime mover. That motion is known as the sun and planet, the one revolving on its centre, and the other in its orbit.

The difference, then, consists in this, that instead of the wheel being fixed, it is left loose on its centre, and fixed into another wheel revolving on its centre on the shaft. They are then brought under subjection, and a give and take motion is the result, by the concentration of the motion by these bevel wheels revolving in their orbits.

2. The differential motion and its diversity of operation.

This differential motion, then, is only a modification, as we shall endeavour to show. The driving shaft in this case is the prime mover; and the arrangement of wheels, as they are now placed in the roving, is to modify, increase, or diminish the direct motion to the bobbin. Its power of diversity of operation is this, that for two revolutions of the shaft or prime mover, the differential wheel will only give one, and the socket not to move. For two revolutions of the shaft, the differential

wheel held fast, the socket will revolve twice in the opposite direction. For eight revolutions of shaft and one of differential wheel, the socket will revolve six times in the opposite direction; and for 200 revolutions of shaft and 20 of differential wheel, the socket will revolve 160 times in the opposite direction to the prime mover; so it will be observed this combination of wheels is capable of modifying, increasing, or diminishing, or stopping entirely if necessary, any direct motion on which they are placed.

3. Rule to find the differential motions.

Double the number of revolutions of the differential wheel, and subtract that sum from the revolutions of the shaft, and that sum is the number of revolutions of the socket wheel running contrary to the shaft.

4. Its adaptation to the roving.

Such a motion as this is particularly well adapted to the requirements of the roving.

The first or prime mover being directly positive, is nevertheless governed by a negative motion to regulate the speed of the bobbin, the delicacy of its action being susceptible to the reversing action of the lifter. This motion is known as the disc and friction; and although simple in construction, is of as much importance as the one just spoken of. This motion takes its power from the prime mover by the twist pinion, large intermediate wheel, and disc shaft to discs.

This motion has often been the cause of immense bother and vexation, when its proper adjustment for working is not properly understood and the cause rectified in the proper quarter, which, when it does happen, no other change can modify, as will be shown from the following example :—

5. Peculiarities of the disc.

It has frequently been found that the friction pulley of a roving working is hard into the centre of the discs before the bobbin is quite full. Well, what is to be done? The friction pulley may be put farther out

on the discs, but only to drag the rove, and the result has its effects upon the yarn.

6. Rule to find the place of the friction on the discs.

Take the diameter of the disc just where the friction pulley is when farthest out; and then, as that diameter is to the diameter or number of teeth in the first pinion on the disc shaft, so will the diameter where you want the friction to work on the disc be to the diameter of or teeth of a larger wheel.

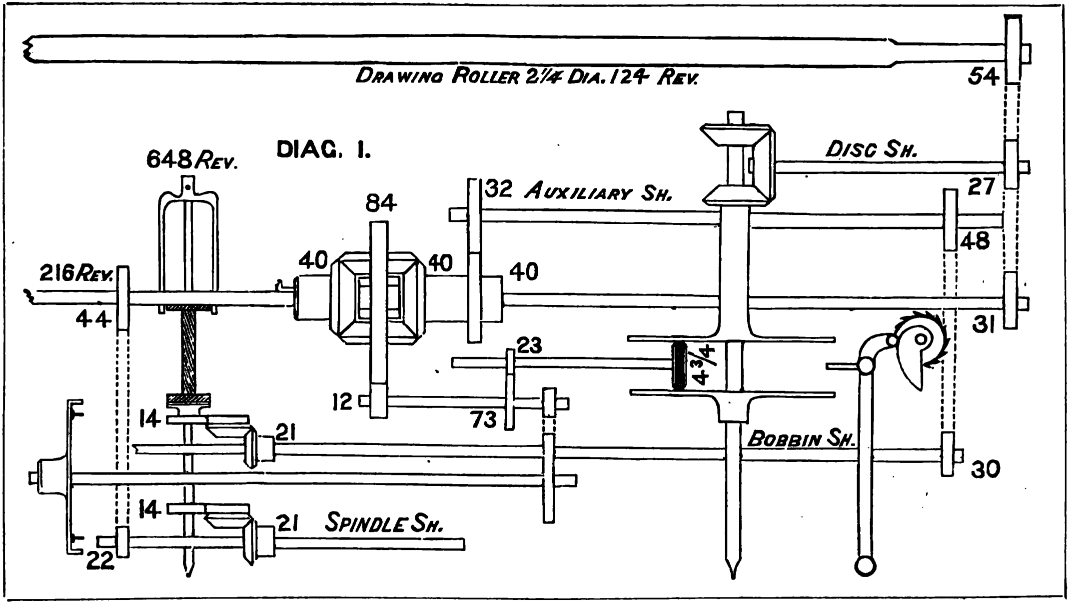
Or, perhaps, an easier way to ascertain the pinion necessary without calculation would be to observe that, in most ordinary cases the wheels are so calculated that the number of teeth on disc shaft pinion should be one half of the number of teeth on drawing roller wheel. The larger the pinion the farther out must the friction be on the disc, and *vice versa* if smaller. So, therefore, the friction pulley can be made to work on the disc where you please, and find plenty of room on both sides of it when properly placed.

7. The practical use of the differential motions; also, 8, 9, and 10.

Diagram 1.—The spindles of the roving in question are to be supposed to run at 648 revolutions, and the drawing roller 124, $2\frac{1}{4}$ diameter, or 7 inches circumference, and delivering 868 inches of sliver per minute. It then resolves itself into a question.

8. The relative motions of the fly, bobbin, and drawing roller.

As whatever length of sliver may be delivered by the drawing roller in a given time, so must the speed of the differential wheel be, to modify the direct motion to the bobbin filling, at a given diameter. The direct motion to the bobbin, be it observed, independent of the differential wheel motion, is the same as the spindles—viz., 648. The surface of the bobbin, then, being winded on, must always be at the same speed as the surface of the drawing roller, *less* that speed on the fly, so that the bobbin, being only a follower, the fly must lay the rove on.


DRAWING ROLLER 2¼ DIA. 124 REV.
54
DISC SH.
27
48
31
30
BOBBIN SH.
4¾
32
AUXILIARY SH.
40
40
40
84
23
73
12
648 REV.
216 REV.
44
14
21
14
21
SPINDLE SH.
22

DIAG. I.

9. How the twist is put on.

Both are then made to go together in unison at increased speed to put on the proper twist required. The bobbin, as it fills, continues at a gradually advancing speed after the fly, but never making up with it, being always exactly the speed of the surface of the drawing roller behind the speed of the fly at the diameter then being winded on.

10. To find the speed of the differential wheel to start the bobbin.

Suppose, then, we were to begin to fill a bobbin 10 × 5, the body of which is $1\frac{9}{16}$ inches diameter, we must first find the speed necessary for the differential wheel, and will begin first with the speed of the drawing roller, taking wheels, pinions, disc, friction, and differential wheel. We find by so doing, the differential wheel gives 29·5 revolutions. And then, not forgetting our first rule, to double this sum and subtract it from the revolutions of the shaft, to find the speed of the socket wheel.

motions to perform their duty. We advance now until the bobbin is filling at $2\frac{1}{4}$ inches diameter, the same diameter as the drawing roller. The friction will then be $1\frac{7}{8}$ inches nearer the centre of the disc, or equal to $3\frac{3}{4}$ inches less in diameter. The speed of the bobbin will then be 524, being 124 revolutions less than the fly, or equal to the speed of the roller at the same diameter, the result being that the rove must be laid on by the fly,

$$\frac{124 \times 54 \times 8{\cdot}80 \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 20{\cdot}68 \times 2 = 41{\cdot}36$$

subtracted from $\frac{216 = 174{\cdot}64 \times 40 \times 48 \times 21}{32 \times 30 \times 14}$ $= 524$ revolutions of bobbin, $648 - 524 = 124 \times 7$, circumference of bobbin $= 868$ inches of rove laid on per minute.

13. The positions of the motions, and wheels to find them.

The lifter having now continued to let go the ratchet at each traverse, and the friction to travel towards the centre of the disc, it might now be supposed that the bobbin is about full at $4\frac{7}{8}$ inches diameter, and the friction working at 4 inches diameter on the disc. We then find the proof of the bobbin's

11. To find the speed of the bobbin from the socket.

And from socket wheel, again, with wheels and pinions to the bobbin, it gives 470·91 revolutions, equal to 177 less than the spindles, which multiply by 4·9 inches, the circumference of bobbin body, and it will be found the bobbin has retarded in speed by the differential, and the fly has laid on 867·74 inches of rove.

$$\frac{124 \times 54 \times 12{\cdot}56 \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 29{\cdot}515 \text{ revolu-}$$

tions of differential wheel, double this is equal to 59·03, which subtract from speed of shaft

$$= \frac{156{\cdot}97 \times 40 \times 48 \times 21}{32 \times 30 \times 14} = 470{\cdot}91 \text{ revolutions}$$

of bobbin, which subtract from speed of spindle, $648 - 470{\cdot}91 = 177{\cdot}09 \times 4{\cdot}9 = 867{\cdot}74$ inches of rove laid on per minute.

12. Calculations of the bobbin being filled to $2\frac{1}{4}$, $3\frac{1}{4}$, and $4\frac{7}{8}$ inches diameter.

A fair start having now been made, it all depends upon the ratchet, snail, and disc

motions to perform their duty. We advance now until the bobbin is filling at $2\frac{1}{4}$ inches diameter, the same diameter as the drawing roller. The friction will then be $1\frac{7}{8}$ inches nearer the centre of the disc, or equal to $3\frac{3}{4}$ inches less in diameter. The speed of the bobbin will then be 524, being 124 revolutions less than the fly, or equal to the speed of the roller at the same diameter, the result being that the rove must be laid on by the fly,

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13. The positions of the motions, and wheels to find them.

The lifter having now continued to let go the ratchet at each traverse, and the friction to travel towards the centre of the disc, it might now be supposed that the bobbin is about full at $4\frac{7}{8}$ inches diameter, and the friction working at 4 inches diameter on the disc. We then find the proof of the bobbin's

movements as before, — by calculation. Take as a first numerator the speed of the drawing roller, say 124 revolutions, wheel on end 54, first pinion on disc shaft 27, and working diameter on disc 4 inches, being at the farthest in circle of its traverse, and the bobbin full. Friction pulley $4\frac{3}{4}$ inches diameter, pinion on the other end of shaft 23, driving a small shaft with a wheel on it of 73, and pinion on it 12, driving differential wheel of 84. We then find by multiplying these sums together, and dividing the numerators by the denominators, the result to be 9·4 as the revolutions of the differential wheel; and having found this, it gives a key to find the speed of the bobbin.

14. To find the length of rove the fly has laid on.

Proceed again with the shaft at 216 revolutions, and double as before stated the revolutions of differential wheel $9{\cdot}4 = 18{\cdot}8$, which, subtracted from 216, leaves 197·2 as the speed of socket wheel at the back of the differential, which has on it a 40, and from it to the auxiliary shaft a 32, and on the

other end of it a 48, to pinion of 30 on bobbin shaft, and a 21 bevel on bobbin shaft to a 14 on bobbin driver. And dividing the wheels by their pinions we have the sum of 591·6 revolutions of bobbin. And the speed of the spindles being 648, from which take the speed of bobbin, and it is found to fall back 56·4 revolutions. Then multiply this by the circumference of the bobbin just now full at $4\frac{7}{8}$ inches diameter, and we find the sum of 867·99 inches of rove which the fly has laid on the bobbin per minute.

$$\frac{124 \times 54 \times 4 \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 9{\cdot}4 \times 2 = 18{\cdot}8$$

subtracted from $216 = \dfrac{197{\cdot}2 \times 40 \times 48 \times 21}{32 \times 30 \times 14}$ $= 591{\cdot}6$ subtracted from $648 = 56{\cdot}4 \times 15{\cdot}39$ $= 867{\cdot}99$ inches of rove.

15. Rule for corresponding diameters of disc and bobbin.

First fix on a certain diameter on the disc, on which to drive the friction. Then, for numerators, take the revolutions of drawing roller, wheel on end of ditto, diameter on disc, wheel on end of friction shaft, and wheel driving the differential wheel. Then,

as denominators, take pinion on end of disc shaft, diameter of friction pulley, wheel on short shaft under the friction shaft, and differential wheel; and the sum found from the above will be the revolutions of differential wheel.

Then, again, find the speed of shaft, from which subtract twice the speed of the differential wheel. The sum found is the first numerator, to which multiply the number of teeth in socket wheel, and teeth in wheel on auxiliary shaft and bevel wheel on bobbin shaft. And for denominators, take pinion on auxiliary shaft, and ditto on end of bobbin shaft and bobbin driver; and the sum found is the revolutions of bobbin. Then, from speed of spindle subtract speed of bobbin, and this sum is the revolutions the bobbin has fallen back. Then, again, divide the number of inches delivered by the roller per minute by the number of revolutions the bobbin has fallen back, and the sum found is the circumference of the bobbin then filling; and as 22 is to 7, so is the circumference to the diameter. And the revolutions of bobbin, subtracted from speed of spindles and multiplied by the circumference ot bobbin filling, will give the number of inches laid on by the fly.

$$\frac{124 \times 54 \times 6 \text{ in.} \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 14{\cdot}0999 \times 2 =$$

28·1998 subtracted from speed of shaft,

$$\frac{216 = 187{\cdot}8002 \times 40 \times 48 \times 21}{32 \times 30 \times 14} = 563{\cdot}4006$$

subtracted from 648 = 84·5994 revolutions the bobbin has fallen back in speed to the spindle. 868 ÷ 84·5994 = 10·26 inches circumference of bobbin. 648 − 563·4006 = 84·5994 × 10·26 = 867·98 inches of rove laid on by the fly. As 22 is to 7, so is 10·26 to 3·264 inches diameter of bobbin filling.

TABLE OF THE RESULT OF THE CALCULATIONS OF THE FOUR FOREGOING MOTIONS.

Diam. of Bobbin.	Circum. of Bobbin.	Revolutions of Differential Wheel.	Revolutions of Bobbin.	Diam. on Discs.	Inches of Rove laid on.
$1\frac{9}{16}$	4·9	29·515	470·91	12·56	867·74
$2\frac{1}{4}$	7	20·68	524	8·80	868
3·264	10·26	14·0999	563·4006	6	867·989
$4\frac{7}{8}$	15·39	9·4	591·6	4	867·99

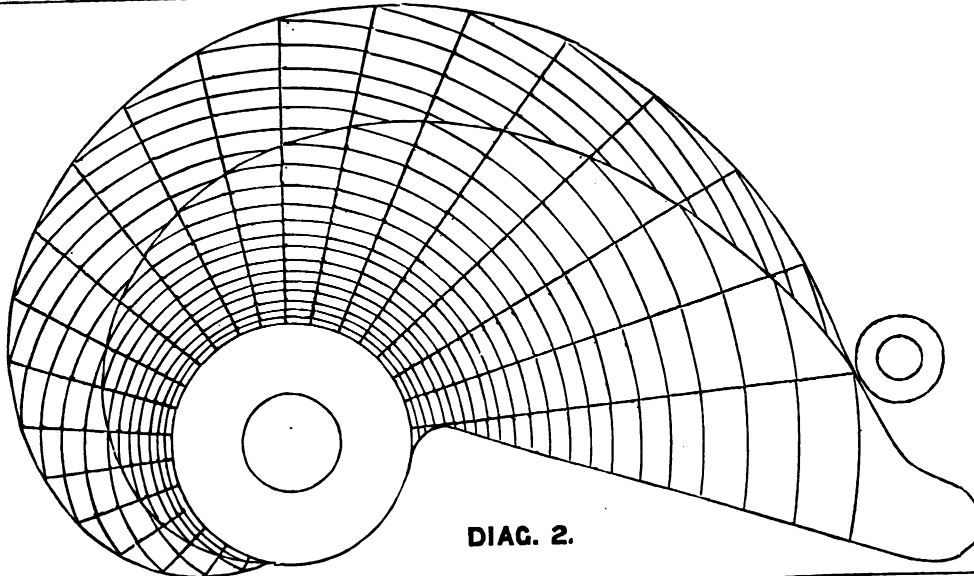
It might further be observed that the spindles make three revolutions to one of driving shaft. Example, *Diagram* 1:—Speed of shaft 216 × 3 = 648 revolutions of spindles; and the bobbins make three revolutions to one of the socket wheel, which is controlled by the differential wheel, as example at 11th

section of rules, where the socket wheel gives 156·97 revolutions × 3 = 470·91 revolutions of bobbin.

16. Peculiarity of the snail or scroll, and its descent on the discs.

There is a strange peculiarity about this motion, to which we would direct your attention.

It is not now to be supposed that a nicely cut ratchet wheel, having made its alternate leap and regularity of pitch, has built us that finely laid-on rove. No; we must go to the other end of the shaft, and there we find the snail, insignificant as it looks, with nothing very particular about it but just to check the progress of the friction towards the centre of the discs, yet you will find there is more on its back than is generally believed to be. Were its changes to make a regular uniform step by step on the discs towards the centre of probably ¼th inch at a time, the form of snail would be as represented by the outside lines of *Diagram* 2. The result would be equal to winding up the properly-adjusted snail to increased diameter, and so extending the diameter on the disc, and thereby retarding the speed of the bobbin



DIAG. 2.

and breaking the rove; and to obviate this, the scroll is made as represented by the inner portion of the diagram, to allow the friction to come in towards the centre of the discs at a gradually reduced step, at the same time giving an equally proportionate increase of speed to the bobbin on each alternate traverse of the lifter; beginning with, it may be $\frac{5}{8}$ths of an inch, and when full a little over $\frac{1}{16}$th of an inch of shift on the friction.

17. The bobbin driven by compound motions.

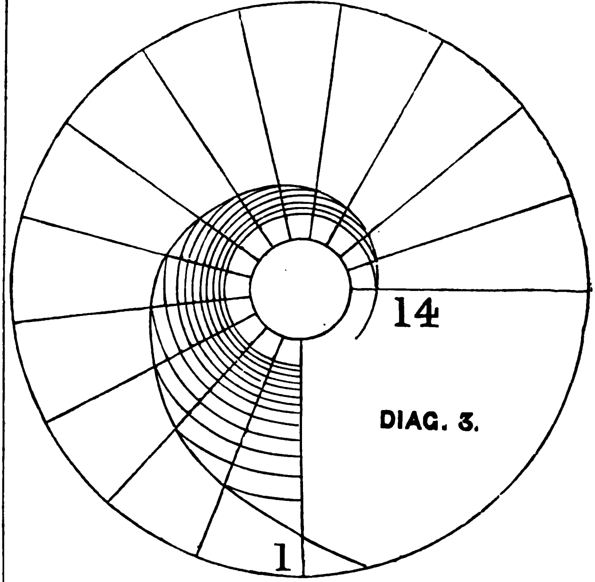
So you will discover that the diameters on the disc and bobbin, although working in exact relation to one another, are governed by two compound motions, both giving increased speed to the bobbin during the process of filling, by the increased speed given to the differential at starting and its being gradually reduced in speed by the traverse changes of the friction. The first point of compensation between these motions is in the form of the scroll, which must be made not to allow the friction to travel at an equal measured step, but every traverse of the lifter giving less travel in succession to another, as shown on the diagram.

18. THE SCROLL DIFFICULTY, AND HOW TO MAKE A SCROLL.

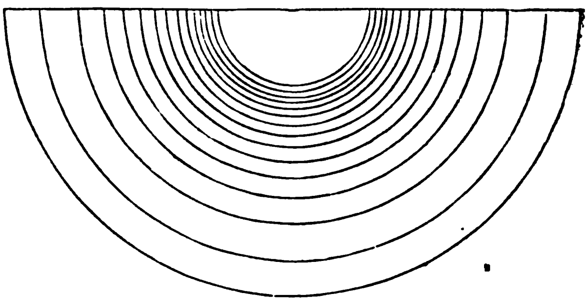
The greatest difficulty to be overcome in this machine is to know how to make by rule a properly adjusted form of scroll, and that form may be obtained by reference to *Diagram* 3 and the following instructions:—

TABLE OF DIAMETERS OF BOBBIN, DISC, AND SCROLL.

No. of Points.	Diameter of Bobbin.	Diameter on Disc and Scroll.	Half Diameter of ditto.
1.	1·5 in.	13 in.	6·5
2.	1·75 „	11·143 „	5·57
3.	2 „	9·75 „	4·87
4.	2·25 „	8·666 „	4·33
5.	2·5 „	7·8 „	3·9
6.	2·75 „	7·09 „	3·54
7.	3 „	6·5 „	3·25
8.	3·25 „	6 „	3
9.	3·5 „	5·571 „	2·78
10.	3·75 „	5·2 „	2·6
11.	4 „	4·875 „	2·43
12.	4·25 „	4·588 „	2·29
13.	4·5 „	4·333 „	2·16
14.	4·75 „	4·105 „	2·05



DISC & SCROLL. SCALE $\frac{2}{10} = 1''$.

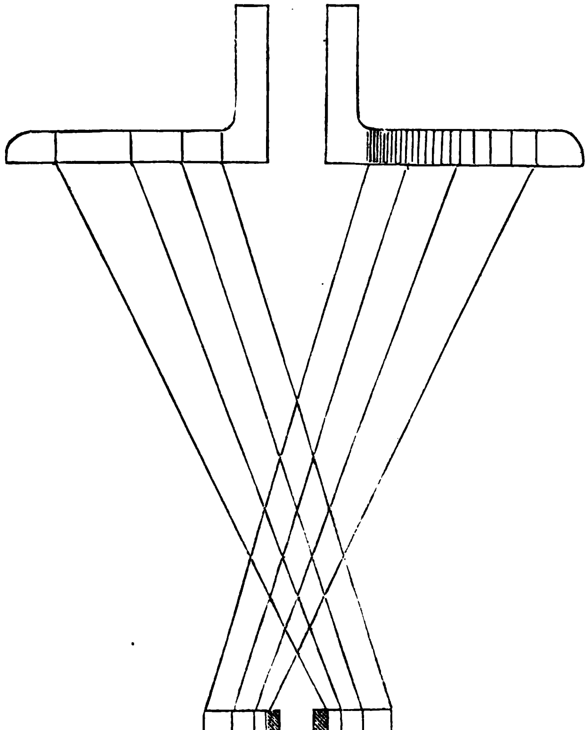


Suppose that the rove was to increase a quarter of an inch in diameter on each traverse of the lifter, and the bobbin to begin to fill at $1\frac{1}{2}$ inches in diameter, and when full 5 inches, it would then increase $3\frac{1}{2}$ inches in diameter, or 14 traverses of rove to lay on. We shall then say three-fourths of a circle will be considered sufficient to throw out the friction in its required traverse. Divide this three-fourths of a circle into 14 equal parts, and draw radius lines from the centre to any diameter. Then, as $1\frac{1}{2}$ inches of body of bobbin is to 13 inches diameter on disc, so will the corresponding diameters, increased by quarters of an inch on the bobbin, be equal to their corresponding diameters on disc by inverse proportion. Take that scale of diameters of disc now found, and lay it on one of the end radius lines with the finest pitch towards the centre, and mark the same scale on it, the larger diameter to be 13 inches — the same as diameter fixed on on the disc — and with compasses describe lines from the scale, so marked as to intersect the radius lines, and again draw a line over these intersecting points, and you have the form of scroll required that will do for any size of rove by putting on a corresponding ratchet

wheel. This ratchet wheel has generally odd numbers by Fairbairn, and Lawson's even numbers. Both work equally well, seeing that the catches are so placed as to give a tooth and blank alternately. This ratchet does not require to give a whole round, as the scroll does not admit of it; so that a 15 teeth ratchet gives equal to 30 traverses, while only 11 are required, giving 22, as shown on referring to *Diagram* 4.

The rod giving the direct action from the scroll to the friction is supported on the upper end of a vertical lever, and the higher the centre of the scroll is above the centre line of the friction pulley the larger will the diameters of the scroll require to be, to be kept in equal ratio to the traverse required on the face of the disc; and one scroll so made will do for any size of bobbin up to 5 inches diameter by observing the rule stated in the sixth section. If the scroll is not large enough, put the friction on the disc where you want it, and the small friction bearing on the scroll where you want it, and change pinion 27 on *Diagram* 1 to correspond to the diameters, to give the speed wanted to the friction pulley.

Four calculations have been given, the more correctly to discover the exact dia-



DIAG. 4

DISC & BOBBIN. SCALE $\frac{2}{10}=1''$

meters on disc to those on the bobbin filling, but which will be better understood by reference to *Diagram* 4. As $12\frac{1}{2}$ inches diameter on disc are to $1\frac{9}{16}$ of bobbin, so will 4 inches on disc be to $4\frac{7}{8}$ of bobbin; and again, as $8\frac{3}{4}$ inches diameter on disc are to $2\frac{1}{4}$ on bobbin, so will 6 inches on disc be to $3\frac{1}{4}$ of bobbin by inverse proportion; and by simple ratio, as 4 inches diameter on disc are to $12\frac{1}{2}$ on the same, so will $1\frac{9}{16}$ of bobbin be to $4\frac{7}{8}$ of the same; and as six inches of diameter on disc are to $8\frac{3}{4}$ on ditto, so will $2\frac{1}{4}$ of bobbin be to $3\frac{1}{4}$ on the same.

By reference to *Diagram* 4, it will be seen that the larger diameter of the disc corresponds to the smaller diameter of bobbin, and the descent of the one is always in ratio to the increased diameter of the other.

19. The laying on of the rove.

There is still another motion to which attention should be directed. That is the laying on of the rove. There is a small intervening shaft between the friction pulley and differential wheel, the one end of which drives the differential, and the other end—the pinion—drives the builder. This pinion

can be changed to lay on the rove at any desired pitch, so as neither to lap nor so wide as to sink, and so cause unequal tension on the rove. The smaller the pinion the closer will the rove be laid, and *vice versa* if larger. The disc and friction motion drives the lifter, and gives, by the descent of diameters on the disc, an exact decrease of speed to the lifter in equal ratio to the filling of the bobbin. 60 rounds of an 80 lbs. per spindle rove on a 10-inch traverse will make a uniformly filled bobbin.

20. Rule to find the twist.

And, further, regarding the twist of this machine. It is found by multiplying together the number of teeth in the roller wheel, wheel on driving shaft and spindle shaft together for a numerator, and multiplying together also the teeth in twist pinion, pinion on spindle shaft, spindle pinion and circumference of roller for a denominator, and dividing the former by the latter, the result being the twist in turns per inch.

Example : — Drawing roller wheel 54, wheel on driving shaft driving spindles 44, spindle shaft pinion 21, twist pinion on end

of driving shaft 31, pinion on end of spindle shaft 22, spindle pinion 14, circumference of roller 7 inches.

$$\frac{54 \times 44 \times 21}{31 \times 22 \times 14 \times 7} = \cdot 74 \text{ turns per inch, or}$$

divide the speed of the spindles by the number of inches of sliver delivered— $648 \div 868 = \cdot 74$ turns.

21. The influence of the twist pinion on the motions.

The twist pinion may be said to have the whole governing power over this machine. From its central position it changes the speed of every motion save the spindles. Suppose that we have on a 31, but it is found necessary to increase the twist 3 teeth, a 28 is put on, and the drawing roller being driven that much slower the twist is increased. But what of the other motions and the winding on of the rove? This same pinion being reduced has reduced the speed of the disc motion, and that again to the differential. When here the direct motion takes cognizance of it, and runs off with increased speed of the bobbin, exactly in ratio to the decreased speed of the drawing roller. Were this not the case, the fly would immedi-

ately break the rove by its not coming fast enough to be laid on, so therefore increased speed of the bobbin is a necessity to maintain the proper tension of the rove. And again, to the contrary, were the twist to be softened by the increased speed of the drawing roller, the disc and differential motions increase also, and the bobbin falls back, allowing the increased length to be laid on.

The direct principle of the machine, therefore, is this regarding the rove. The spindles are at one uniform speed, giving twist according to the revolutions of the drawing roller; and the other motions, positive and negative, hold the speed of the bobbin in subjection to maintain the proper tension and winding on of the rove.

22. The result without the motions, and intersection of them.

The most prominent peculiarity of the foregoing motions then is this, that without the differential motion the bobbins would go too fast at any part of the process of filling. Therefore, the differential motion is put in to maintain the speed of the bobbin in unison to its diameter. The slower the

differential goes, the faster will the bobbin go during the process of filling.

The bobbin, being a follower, must of necessity as it fills run faster, the rove being laid on by the fly; but were the bobbin a leader, it would go at the speed of the surface of the drawing roller faster than the fly; and consequently, must pull on the rove in the opposite direction, instead of having it laid on as we find it in the flax and jute manufacture. And one other peculiarity of the differential motion is this, that while the direct motion passes right through the differential motion, it is clean cut through, and although separate, is still entirely under the control of the disc and snail motions.

23. The perfectness of the combination of the motions.

This machine is so complicated in its construction, that the smallest neglect or inattention to any one of its comparatively small minutiæ of parts causes grievous annoyance, whereas by proper attention, it has a delicacy of treating the most delicate material in its operation, which is unsurpassed by any other machine yet introduced into our modern spinning mill.

PART SECOND.

1. The bobbin as a leader.

The second part of this Essay shall take into consideration the nature of the motions and changes required to make the bobbin a leader.

Having found the circumference of the bobbins at the various diameters mentioned in the foregoing calculations, divide the number of inches delivered by the drawing roller per minute by the circumference of bobbin, and the sum found is the number of revolutions required of the bobbin to wind on the same length of rove, and the revolutions so found, added to the speed of the spindle, will give the speed of the bobbin as a leader.

Examples.

Diam. of Bobbin.	Inches delivered.		Circum. of Bobbin.		Rev. Bobb. required, &c.		Rev. of Spindle.		Leading rev. of Bobbin.
1·562	868	÷	4·9	=	177	+	648	=	825
2·25	868	÷	7	=	124	+	648	=	772
3·264	868	÷	10·26	=	84·6	+	648	=	732·6
4·875	868	÷	15·39	=	56·4	+	648	=	704·4

On starting to fill the bobbins at $1\frac{9}{16}$ diameter as a follower, its speed per minute is 470·91, but as a leader 825, being 354 revolutions faster at starting; and at $4\frac{3}{8}$ diameter as a follower 591·6, but as a leader 704·4. As a follower, the bobbin increases in speed from 470·91 to 591·6; but as a leader the reverse is the case—the bobbin decreases from 825 to 704·4. These data are based on the assumption that the driving shaft of the roving is giving 216 revolutions, and the spindles 648 per minute.

Having now discovered the relative speed of the bobbin to the flyers and drawing roller, we shall now endeavour to give a rule not unlike the first given, for the bobbin as a follower. Observe, in the first place, that, the bobbin as a follower, the differential wheel must run in the same direction as the shaft, but, as a leader, it must run contrary or in the opposite direction. Then double the number of revolutions of the differential wheel, running contrary to the shaft, and add that sum to the revolutions of the shaft, and this sum so found is the revolutions of socket, also running contrary to the shaft. Begin then, as before, with the speed of the drawing roller at 124 revolutions, and descend by wheels, pinions,

diameter on disc, friction, &c., to the differential wheel, and double its number of revolutions as stated, add the sum to the speed of the shaft to find the speed of the socket, and then descend again with its speed and by wheels and pinions to the bobbin to find the speed of the bobbin. Then, from the speed of the bobbin, subtract the speed of the spindle, and the sum is the number of revolutions the bobbin has overrun the speed of the spindle. Then, again, divide the number of inches delivered by the roller per minute by the number of revolutions the bobbin has overrun the spindle, and the sum found is the circumference of the bobbin then filling. Examples made from the former calculations :—

$$\frac{124 \times 54 \times 12{\cdot}56 \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 29{\cdot}515 \times 2 =$$

$$59{\cdot}03 + 216 = \frac{275{\cdot}03 \times 40 \times 48 \times 21}{32 \times 30 \times 14} = 825 -$$

648 = 177 revolutions faster than the spindle. 868 $\div$ 177 = 4·9 circumference of bobbin. At $2\frac{1}{4}$ diameter of bobbin,

$$\frac{124 \times 54 \times 8{\cdot}80 \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 20{\cdot}68 \times 2 =$$

$$41{\cdot}36 + 216 = \frac{257{\cdot}36 \times 40 \times 48 \times 21}{32 \times 30 \times 14} = 772$$

— 648 = 124 × 7 inches circumference = 868

inches of rove wound on by the bobbin, and $868 \div 124 = 7$ inches circumference.

At 3·264 diameter of bobbin,

$$\frac{124 \times 54 \times 6 \quad \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 14{\cdot}0999 \times 2 =$$

$$28{\cdot}1998 + 216 = \frac{244{\cdot}1998 \times 40 \times 48 \times 21}{32 \times 30 \times 14} =$$

732·6 revolutions of bobbin, from which subtract speed of spindles $648 = 84{\cdot}6 \times 10{\cdot}26$ inches circumference $= 867{\cdot}996$ inches of rove wound on, and $868 \div 84{\cdot}6$ revolutions the bobbin has overrun the speed of the spindle, gives 10·26 as the circumference of the bobbin then filling.

And at $4\frac{7}{8}$ths diameter of bobbin the calculation would be as follows:—

$$\frac{124 \times 54 \times 4 \quad \times 23 \times 12}{27 \times 4{\cdot}75 \times 73 \times 84} = 9{\cdot}4 \times 2 = 18{\cdot}8 +$$

$$216 = \frac{234{\cdot}8 \times 40 \times 48 \times 21}{32 \times 30 \times 14} = 704{\cdot}4 \text{ revolu-}$$

tions of bobbin, from which subtract the revolutions of the spindle, $648 = 56{\cdot}4$ revolutions faster than the spindle. $868 \div 56{\cdot}4 = 15{\cdot}39$, circumference of bobbin when full.

The foregoing calculations are wrought out a little different in form to avoid sameness, but the results are the same in the end. All tend to prove the relation of the motions.

and the unequal descent on the discs, and may be summed up more clearly in the following :—

TABLE OF THE FOUR FOREGOING RESULTS OF THE BOBBIN AS A LEADER.

Diam. of Bobbin.	Circum. of Bobbin.	Revolutions of Differential Wheel.	Revolutions of Bobbin.	Diam. of Discs.	Inches of Rove wound on.
$1\frac{9}{16}$	4·9	29·515	825	12·56	867·3
$2\frac{1}{4}$	7	20·68	772	8·80	868
3·264	10·26	14·0999	732·6	6	867·99
$4\frac{7}{8}$	15·39	9·4	704·4	4	867·99

It need scarcely be added that there is no reversing action on the bobbin, but only an increase of speed, being equivalent to the speed of the surface of the drawing roller faster than the fly, whereas, as a follower, it was always as much slower.

All the change necessary to make on a roving to make it a leader is to introduce another intermediate wheel between the large intermediate stud wheel and the disc shaft pinion, to reverse the motions of the discs, differential wheel, and builder wheels; and if the bobbins are in the process of filling, turn them upside down, and the bobbin will lead on the rove as well and

equally the same as if it had been a follower. The only caution is to beware of the speed at which you are driving, as the speed of the bobbin is very much increased; and although it is, or would be considered by many, a saving of waste from the rove being thrown off in coarser heavy sizes, still it is not to be recommended unless where there is a good set of wheel gearing to drive the bobbins.

Having now said all that we should consider necessary to make the practical mechanic master of this machine, we now leave it in your hands for consideration and approval.

2. The scroll of the modern roving.

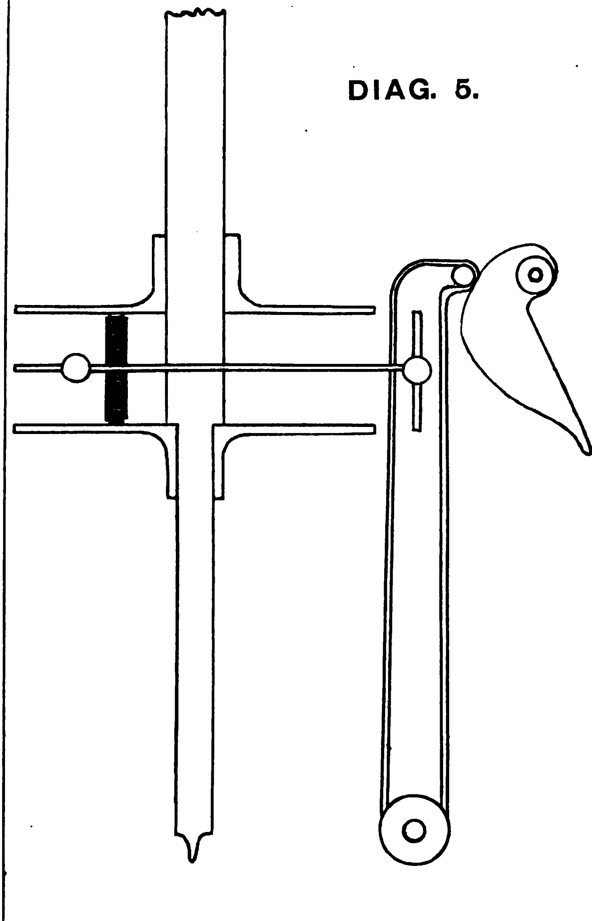
The foregoing Essay being written with the view of being read as the subject of an evening to practical men, it was not absolutely necessary to go into the most minute

details, as they would only serve to perplex and harass the listener. The main object of the subject therefore was the relationship of the bobbin-filling motions.

But, since then, it has received so much favour, and such a wide circulation amongst those professionally in the trade, that a first edition of several hundreds has been sold, and another edition is urgently called for. In the belief that it will receive still greater interest from the amateur and the young mechanic, it has been deemed desirable to make some of its leading and more important parts more plain and distinct; so that, with a knowledge of reading decimal values on the common foot-rule, a pair of compasses and board, any apprentice may soon become able, with a little patience, to make himself thoroughly master of this complicated machine.

The first point of observation we shall refer to is at the middle of page 30, where the vertical lever is mentioned. It is there stated that "the higher the centre of the scroll is above the centre line of the friction pulley the larger will the diameter of the scroll require to be."

We shall now endeavour to shew how



DIAG. 5.

this can be accomplished by the rules formerly given.

This vertical lever and support is 19 inches from the lower centre to the centre line between the discs; and from this centre to the small friction pulley above it is 4 inches, while the head of it is turned over $2\frac{1}{4}$ inches, just sufficient to give it clearance of the scroll in working. (See *Diagram* 5.)

Although the rod that guides the friction pulley is generally set at 19 inches above the lower centre, and corresponds with the centre line of the discs, the vertical lever has a slot that makes it sometimes very convenient to raise or lower this rod to suit a small variation in the size of the rove. Were it lowered, it would not throw out the friction so far, and would slightly slacken the rove at starting; and would, on the bobbin getting full, not be drawn in so far to the centre of the discs, and so make it tighter; this might be done with advantage if the rove were made lighter. While, again, on the other hand, were it raised, it would throw the friction farther out and tighten the tension of the rove at starting; and on the bobbin getting full, the friction would be brought farther into the centre of the discs, and so slacken the rove. This could be

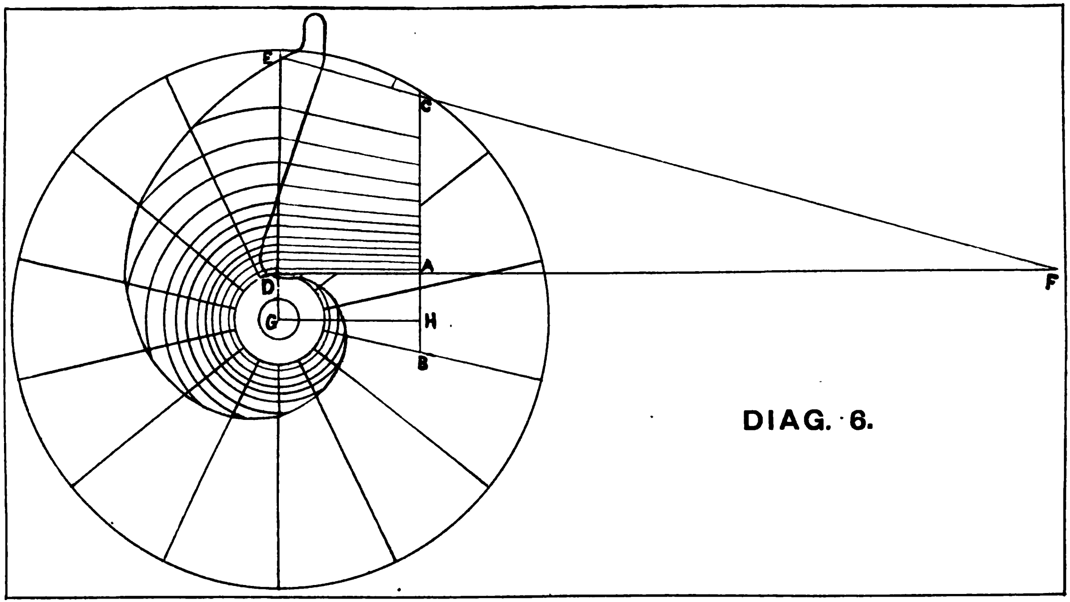
done to advantage if the rove were made a little heavier, as the increased diameter of the bobbin would bring up the required tension.

3. The scroll.

The details, as formerly given, were for a scroll that would be suitable, providing it was placed in line with the friction pulley between the discs. The appliance by this method is now long out of date; and for the convenience of getting the winding up hand-wheel to the front of the roving, the shaft and gearing thereto had to be raised 4 inches to keep clear of the main shaft of the roving, and so requiring a scroll specially made for the increased traverse of the lever.

A new set of tables of diameters might be set down, with perhaps a few more points or radius lines, to make a scroll give its travel in three-fourths or a whole round, and would only require a ratchet with more or less teeth to suit; but, as the present No. 5 scroll now in use gives one whole round, we shall apply the old rules and tables, at page 26, for this purpose.

It will be understood that the placing of



DIAG. 6.

the centre of the scroll at a greater or less distance from the radius points to be given would materially affect its size, although in its working effect it would be entirely the same, only the larger the scroll a finer pitched ratchet would be required. The centre B is therefore raised ·85, or $8\frac{1}{2}$ tenths of an inch, to reduce the size of the nave from the rule formerly given. At the bottom of table of half diameters is 2·05, that is, $2\frac{1}{20}$ inches from the centre, from which take ·85, thus leaving 1·2 tenths; and on referring to *Diagram* 6 are two parallel lines D A and G H, which are to be set 1·2 tenths inch apart. On these lines place a vertical line A C, on which place all the points of the scale of half diameters, taken from B 2·05 inches as a centre up to 6·5 at C, and from H is the line of centre for the diameter required for the scroll at G.

It will now be understood that the travel of the friction on the discs is $4\frac{3}{4}$ inches, and the top of this lever being 4 inches higher, gives a travel of $5\frac{3}{4}$, or 1 inch more, by the radius of the circle. Now, therefore, from the scale just given, we must find another scale in the same ratio, but extended 1 inch higher, while their main centres are the same. From A to D $4\frac{1}{16}$ draw the perpen-

dicular D E, then from D to F 20¼ inches. Draw the intersecting lines from F through A C to D E, and the same scale as on A C will be extended to the perpendicular D E. D to E must then be 1 inch higher than A to C. Then make a circle from the centre G 14 inches diameter, which divide into 14 equal parts, to correspond with the number of points of half diameters marked on A to C; and from the points on perpendicular D E draw the sections of circles as shewn from G as a centre. The intersection of said sections with the radius lines of the circle forms the outline of scroll, the sweeping curve of which will form a correct outline of the scroll now made and sent out with all of Messrs Fairbairn, Kennedy, & Naylor's rovings.

JOSEPH HOVELL.

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